Vessel/Barge Impact

- Development of Numerical Models
for Impacts with Lock Approach Walls

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Problem

- Vessel and barge impact forces are a critical design factor for lock approach walls.
- There is no Corps Engineering Methodology to predict freighter impact load on Great Lakes (e.g., Soo Locks) and coastal facilities available to District Engineers in the rehabilitation of existing structures, especially approach walls to locks, and the design of new structures.
- The design guidance for barge impacts with lock approach walls is under development and is incomplete.

Objective

Develop engineering methodologies to compute the peak impact force when a vessel or barge tow impacts a structure – specifically a lock wall.

Two cases are being evaluated

- **Impacts with stiff-to-rigid approach walls**
- **Impacts with deformable (flexible) wall systems**

Tow impacting flexible fendering system

Background – Full Scale Barge Impact Experiments (R.C. Byrd Lock and Dam, Dec 1998)

Results - Impact loads derived from these full-scale tests formed the basis for the empirical correlation between maximum force and linear momentum; TR-03-3

Lashing Limit State Models (FY05)

Premise 1: The maximum force that can be imparted to a lock wall will be limited by the lashing failures

3 Lashing Limit State Failure Mechanisms were examined.

- **Transverse Lashing Failure**
- **Corner Lashing Failure Mechanism**
- **Longitudinal Lashing Failure**

Result: PC_Software: Limit_LASHING (for District use).

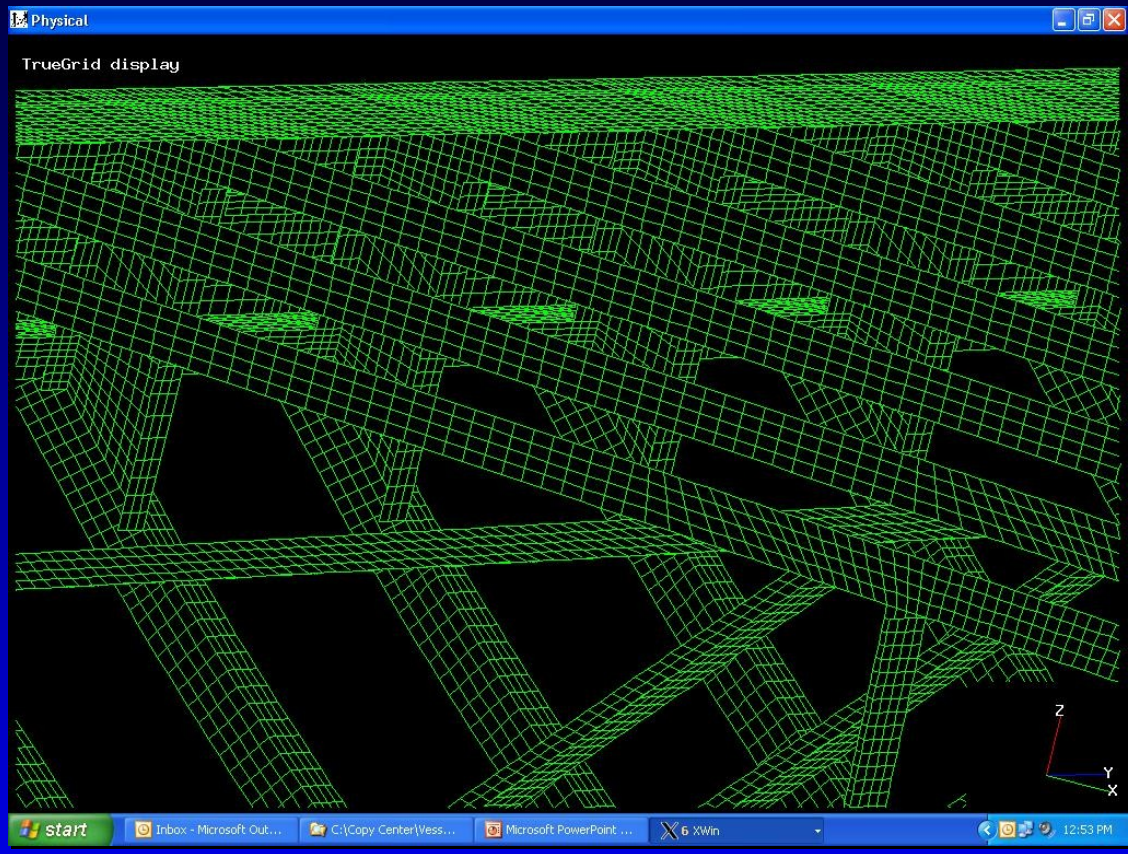
Corner Buckling Limit State Modeling (FY06 and FY07)

Premise 2: The maximum force that can be imparted to the lock wall will be limited by the plastic deformation of the corner during impact.

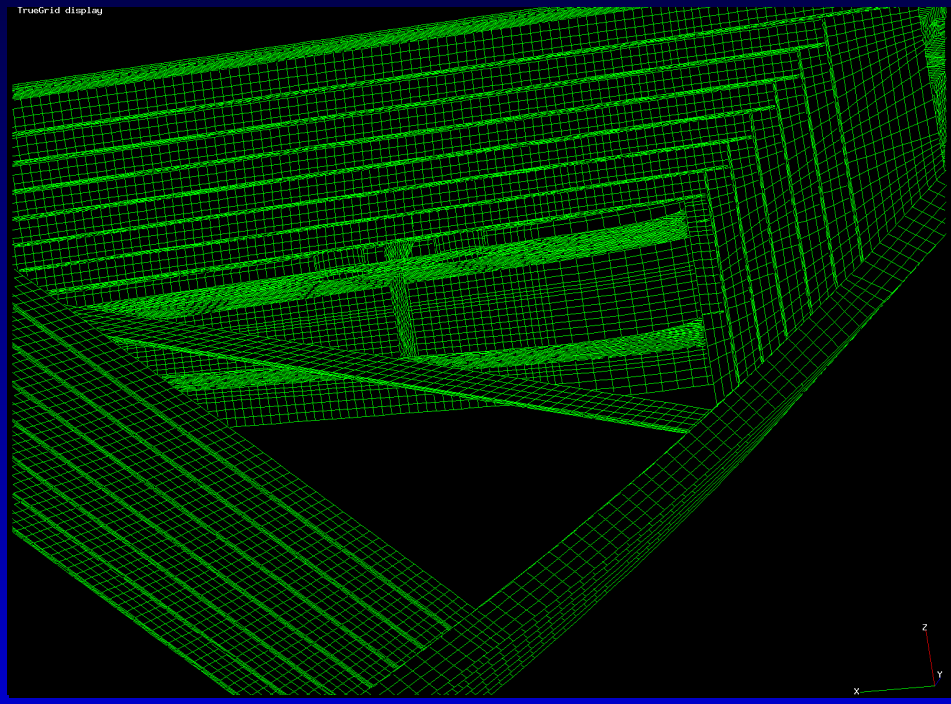
A detailed finite element model of the bow section of a jumbo open hopper barge has been developed for this analysis

Bow Section of a jumbo open hopper barge under construction

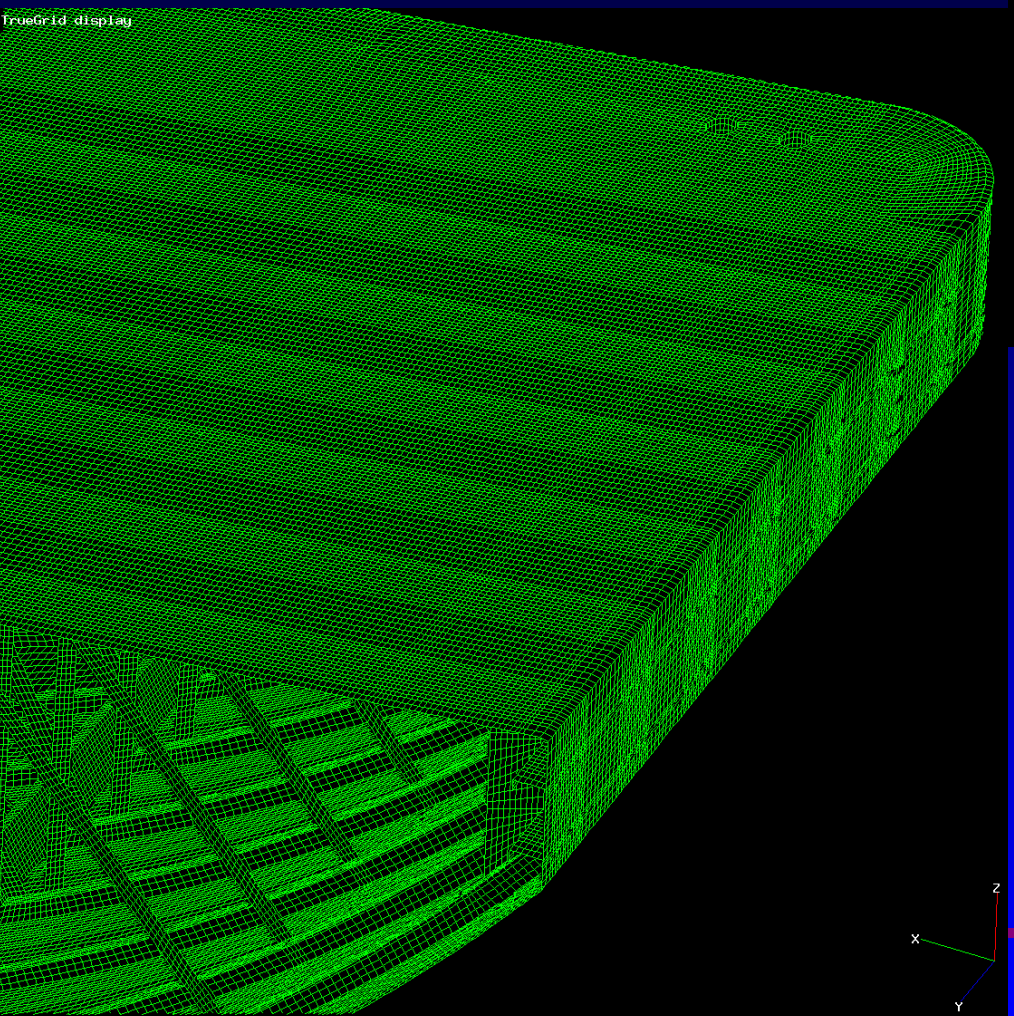
Finite Element (FE) Model
- Structural Truss and Bow -

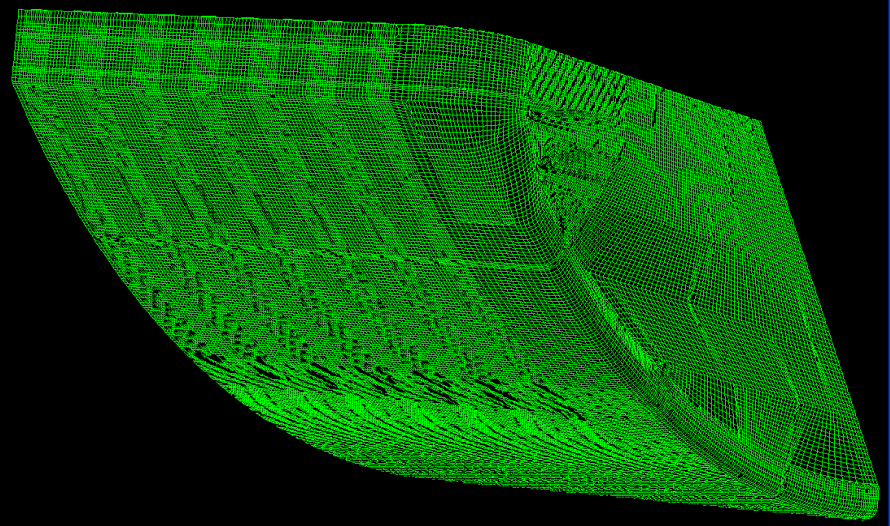


Finite Element Model
- Structural Truss and Bow -



Completed FE Mesh of Barge Corner

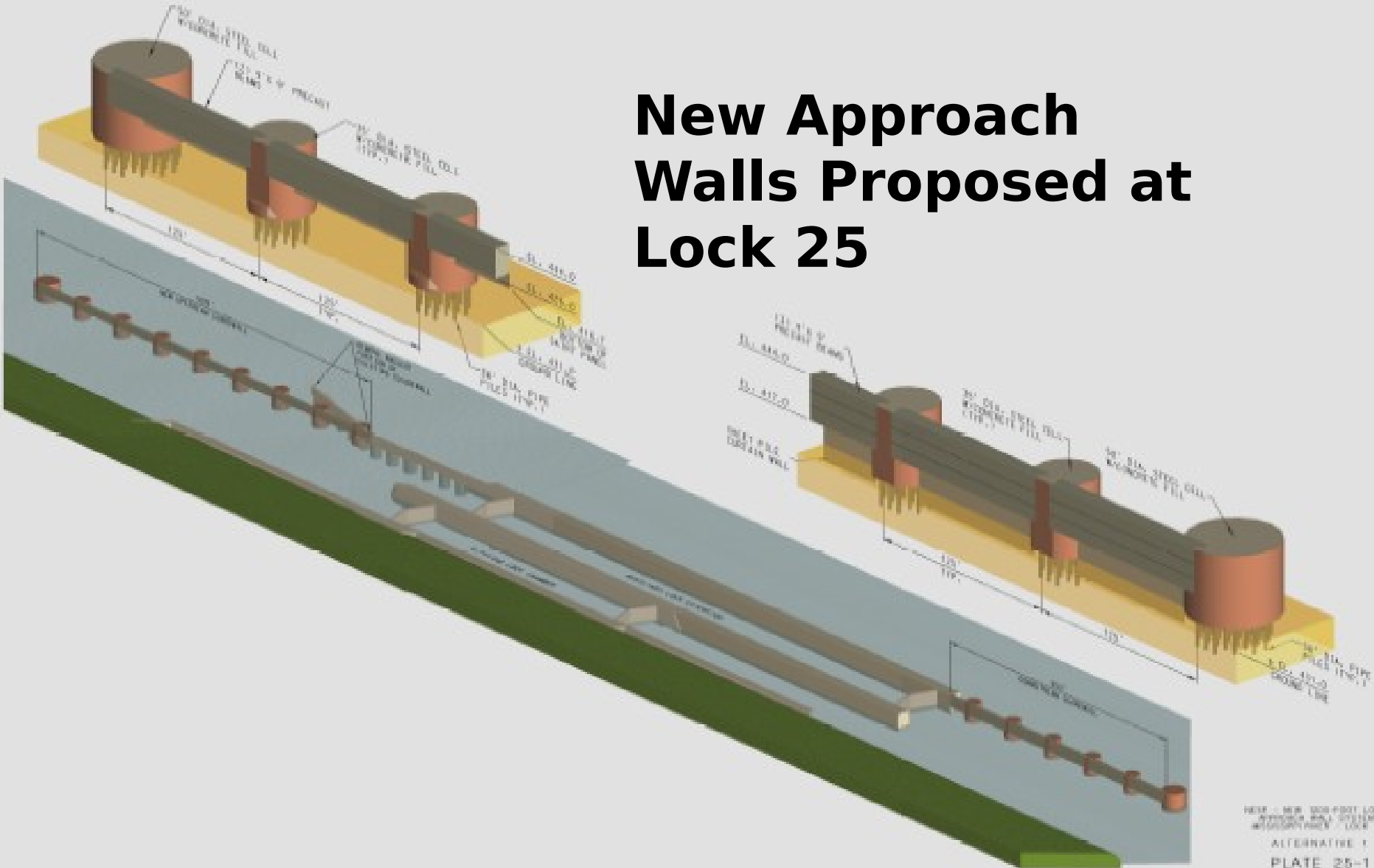




High Performance Computer simulations will be conducted in 2nd quarter FY07 to analyze limit loading due to plate buckling

Research and

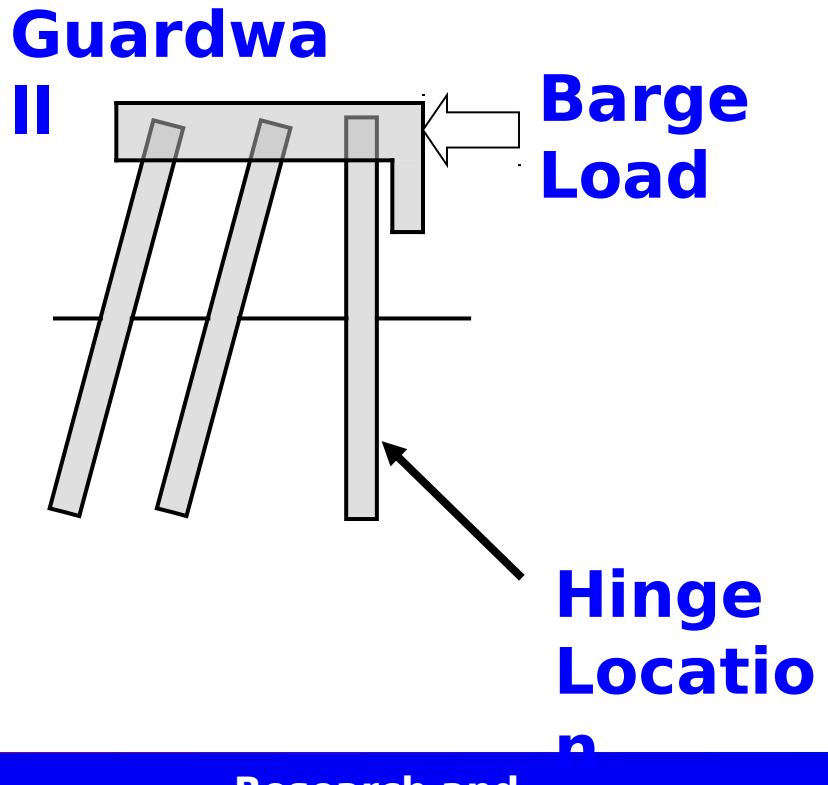
Impacts on Deformable Walls



Deformable Wall Systems

Upcoming projects dependent on accurate BI load assessment on deformable wall systems

- **Lock and Dam 3**
- **Lock and Dam 22**
- **Lock and Dam 25**
- **Soo Locks**
- **Panama Canal**



Full-Scale Barge Impact Testing with a Deformable Wall – Fall 2008

- **Capabilities Being Developed**
  - Quantify force vs. time (demand) parameters needed for structural dynamics modeling of deformable wall impacts under elastic loads
  - Provide calibration input to validate model performance

- **Final Products: An ERDC Technical Report**
  - Summarizing all measurements
  - Providing demand curves for a range of impact angle and velocity
  - Providing corresponding wall response data

Wanted – 1 Fully Ballasted 15 Barge Tow (will return in like new condition)

Please call Bruce at (601) 634-2536

Research and

Products to-date

1. ASCE refereed Journal article “Glancing-Blow Impact Forces by Barge Train on a Lock Approach Wall,” June 2006

2. ERDC/ITL TR 05-1 “Barge Train Maximum Impact Forces Using Limit States for the Lashings between Barges,” March 2005.

3. ERDC/ITL TR 04-2, “A Numerical Model for Computing barge Impact Forces based on Ultimate Strength of the Lashings between Barges,” Aug 2004

4. PC_Software: Limit_LASHING (for District use).

5. ERDC/ITL TR 03-3; “Analysis of Impact Loads from Full-Scale, Low Velocity, Controlled Barge Impact Experiments, December 1998;” Apr 2003.

6. Direct support of new ETL 1110-2-563.

Questions?